APPLICATION FOR UNITED STATES PATENT

in the name of

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for

LASER PROCESSING HEAD

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CLAIM OF PRIORITY

This application claims priority under 35 USC §119 to European Patent Application Serial No. 03005463, filed on March 15, 2003, the entire contents of which are hereby incorporated by reference.

TECHNICAL FIELD

This invention relates to laser cutting and laser welding and, in particular, to a laser processing head.

BACKGROUND

In a laser processing system, a laser processing head forms the end of a beam guidance from the laser to the processing location and focuses the laser beam onto the processing location. Laser processing heads contain supplies for working and/or inert gases, and sensors for distance control from the workpiece. The gases are discharged through a nozzle in the laser processing head towards the processing location on the workpiece. Often a laser cutting gas pressure of up to 20 bar is required for laser cutting to discharge the slag from the kerf.

For a laser power of up to approximately 5 kW, a pressure chamber exists in the cutting head through which the laser beam passes and which is sealed by a focusing lens. The cutting of different sheet thicknesses and materials requires different nozzle cross-sections and bores in the nozzle, as disclosed, for example, in German patent No. DE 3037981.

As an alternative to cutting heads with lens optics, cutting heads with mirror optics also have been used. To generate pressure, so-called annular gap nozzles are thereby generally used, which have a separate pressure chamber and which are disclosed, for example in European Patent Applications Nos. EP 0741627 A1 and EP 0989921 A1.

Mirror optics are used almost exclusively for laser welding due to the greater power and smaller gas pressures that are used with mirror optics. Moreover, mirror optics are less

sensitive to soiling than lens optics, because laser welding tends to produce more soiling than laser cutting, and because mirror optics can be cooled directly.

Generally when the laser power is low, the gas is supplied concentrically to the processing location, and when the laser power is higher, it is supplied from the side.

Laser processing heads often must be slim due to the three-dimensional tasks they perform and to minimize the disturbing (abutting) contour of the head.

To render the machines more flexible, a universally usable processing head is desired that requires as little manual adjustment as possible, i.e., the following adjustments are eliminated: changing of the processing head when switching between laser cutting and laser welding; changing the nozzle to adjust for different materials and material thicknesses; and adjustment of the separation between workpiece and processing head to the respective processing task. These changes are conventionally realized in most cases through mechanical adjustment, pivoting and tilting mechanisms, through beam setting points or through changing stations, where the processing head or the nozzle are replaced as describe, for example, in European Patent No. EP 0411535.

SUMMARY

A compact laser processing head is disclosed that can be adjusted to different processing tasks in a quick, simple and largely automatic fashion, and is also easy to produce.

In a first general aspect, a nozzle of a laser processing head for laser cutting and laser welding includes a laser beam outlet for directing a laser beam towards a processing location of a workpiece to be processed, a first gas supply channel for supplying a cutting gas towards the processing location of a workpiece to be processed when the laser processing head is used for laser cutting, and a second gas supply channel for supplying a welding gas towards the processing location of a workpiece to be processed when the laser processing head is used for laser welding.

The nozzle can include one or more of the following features. For example, the nozzle can include an inner sleeve though which the laser beam passes and an outer sleeve surrounding the inner sleeve, where a first cavity is formed between the inner sleeve and the outer sleeve and wherein the outer sleeve includes a second cavity arranged concentrically with the first cavity. The first cavity can be formed by a first annular gap between the inner

sleeve and the outer sleeve and where the second cavity is formed by a second annular gap formed in the outer sleeve. The first cavity can be formed by an annular channel from which a bore extends to a side of the nozzle. The second cavity can be formed by an annular channel from which a bore extends to a side of the nozzle. The first annular gap can merge into the first gas supply channel and the second annular gap can merge into the second gas supply channel.

The nozzle can further include a channel for supplying a stream of pressurized gas into the laser processing head in a direction perpendicular to a direction of the laser beam. The nozzle can further include a mirror for reflecting the laser beam towards the processing location of a workpiece to be processed. The mirror can be a parabolic focusing mirror. The stream of pressurized gas can be supplied into the processing head between the mirror and the laser beam outlet.

In another general aspect, a method for laser processing of a workpiece includes directing a laser beam through a processing nozzle of a laser processing head to a processing location of a workpiece, supplying a cutting gas towards the processing location through a first gas supply channel of the nozzle when the laser processing head is used for laser cutting and supplying a welding gas towards the processing location through a second gas supply channel of the nozzle when the laser processing head is used for laser cutting, and supplying a stream of pressurized gas in a direction substantially perpendicular to the direction of the laser beam.

The method can include one or more of the following features. For example, the cutting gas and the welding gas are supplied concentrically around the laser beam. The laser beam can be a CO_2 laser beam.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

Fig. 1 is a side sectional view through a nozzle arrangement of a laser processing head.

Fig. 2 is a side sectional view through a laser processing head.

Fig. 3 is a side view showing gas supplies of the laser processing head.

Like reference symbols in the various drawings indicate like elements.

DETAILED DESCRIPTION

Fig. 1 shows a processing nozzle 1 of a laser processing head of a laser-processing machine for guiding a laser beam 5 (e.g., a CO_2 laser beam) and two gases in the direction of the workpiece to be processed. The laser processing head can be used for laser welding as well as for laser cutting tasks. This is realized through the construction of the processing nozzle 1 provided at the tip of the laser processing head. The processing nozzle 1 permits supply of process gas for laser welding as well as cutting gas for laser cutting. The gases are supplied coaxially. Depending on the selected laser processing, a cutting gas or alternatively a working gas / inert gas can be blown in by a control unit (not shown) and associated means such as valves, sensors, pressure controllers etc. For laser cutting, processing is assisted through adding a cutting gas such as oxygen, nitrogen, argon, or air by removing the molten mass from the kerf with or without accompanying oxidation. In laser welding, a process gas such as argon, helium, nitrogen or carbon dioxide is generally used for protecting the welding seam or to support the welding process.

The processing nozzle 1 includes a pressure element 2a and a conical inner sleeve 2b that define a beam-guiding chamber 3 via an opening. The laser beam 5 can exit through an outlet 4 and be focused on the workpiece. An outer sleeve 6 is disposed concentrically with the pressure element 2a and the inner sleeve 2b, wherein an annular gap 7 is defined through arrangement of inner sleeve 2b and outer sleeve 6. The annular gap 7 merges into a first supply channel 9 for supplying cutting gas. A connecting body 8 is disposed on the outer sleeve 6 concentrically thereto. A second supply channel 10 for supplying a welding gas is formed in the connecting body 8 and merges into a second annular gap 11 that extends almost concentrically with the annular gap 7. Depending on the processing task, one or the other type of gas supply can optionally be selected such that either cutting gas is discharged from the gap opening 12 or welding gas is discharged from the channel opening 13. A control unit (not shown) controls whether cutting gas or welding gas is supplied to the processing nozzle 1.

The use of one single processing nozzle 1 and control of the gas supply eliminates the need to change nozzles in many cases, rendering laser processing more flexible. The combination or integration of both laser processing variants in one processing head eliminates the provision and use of mechanical pivoting and tilting mechanisms for changing processing heads and nozzles, because switching between laser cutting and laser processing is realized by means of a control unit through one single processing head. In addition thereto, the disturbing contour of the processing head 1 is small.

An alternative to the second annular gap 11 is an annular channel, disposed concentrically about the annular gap 7 and from which bores extend to the side of the nozzle facing the workpiece.

As shown in Figs. 2 and 3, a parabolic, water-cooled copper mirror 19 is integrated as a focusing element in the laser processing head 14. The focusing position is adjusted through an adaptive copper mirror that is disposed in front of the processing head 14. This is possible also manually through a displacement mechanism of the nozzle and simultaneous adjustment of the distance between the nozzle and the workpiece.

The focusing mirror is protected from process splashes by a stream of pressurized air (a "crossjet") that is blown into the processing head 14 perpendicular to the beam direction though a supply channel 18 or 20. Moreover, the crossjet has the task of protecting the beam guidance from returning gas to prevent inflation of a bellows component of the processing head 14 and to avoid negative influence on the laser beam.

The processing head includes a capacitive distance control. The distance between processing nozzle 1 and workpiece can be programmed and controlled during cutting and also during welding.

In accordance with Fig. 2, a laser processing head 14 for laser welding and for laser cutting has a processing nozzle with a first bore 16 for supply of a welding gas and a second bore 17 for supply of a cutting gas. The welding gas can flow into the bore 16 through the supply 15. Fig. 2 shows, by way of example, the integration of the welding gas and cutting gas supplies in a laser processing head 14. A crossjet 18 protects the beam guidance from returning gas.

Fig. 3 shows a three-dimensional view of the gas supply 15 for the welding gas, the gas supply 21 for the cutting gas and the gas supply 20 for the pressurized air of the crossjet 18.

OTHER EMBODIMENTS

A number of implementations have been described. Nevertheless, it will be understood that various modifications may be made. Accordingly, other implementations are within the scope of the following claims.